REMARKS/ARGUMENTS

Claims 1-20 are in the application. The Examiner has rejected claims 1-20 under 35 U.S.C. § 112 as indefinite. The Examiner has rejected claims 1 and 13 under 35 U.S.C. § 102(b) as anticipated by Mollenauer 3,970,960. The Examiner has rejected claims 2, 3, 6, 8, 9, 11, 12, 14, 15, 18, and 20 under 35 U.S.C. § 103(a) as unpatentable over Mollenauer 3,970,960, Weingarten et al 5,987,049 and Plaessmann et al 5,615,043.

35 U.S.C. § 112 Indefiniteness Rejections:

Referring to Claim 1:

1. Single stage laser amplifying apparatus comprising:

an oscillator assembly for providing input light to be amplified;

a pump laser for providing pumping; and

an amplifier for amplifying the input light from on the order of 10^{-9} Joules to on the order of 10^{-3} Joules, the amplifier pumped by the pump laser;

wherein the amplifier includes a cryogenically-cooled amplifying medium; and

wherein the amplifier provides substantially all of the amplification of

the amplifying apparatus.

The Examiner states that "[*i*]t is vague and indefinite as to what the pump laser is pumping" A specific example from the embodiment of Figure 1 is given below. Note that several other embodiments, and their equivalents, are also within the scope of this claim.

Figure 1 is a first embodiment of the present invention. In this embodiment, pump laser 116 pumps amplifier 112, via pump optics 117. Note that the fourth element of claim 1 specifies that the amplifier is pumped by the pump laser.

The Examiner continues "it is not clear the difference between the *amplifier* and the *oscillator assembly for providing input light to be amplified.*" In Figure 1, oscillator assembly 102, 104, 106, 108 110 provides the light to be amplified. This light is provided to the amplifier 112. Element 1 of Claim 1 specifies that the oscillator assembly provides the light to be amplified, and element three specifies the amplifier. These are separate elements, as in the claim.

The Examiner continues "claim 12 is vague and indefinite as to 'the amplifier includes a cryogenically cooled amplifying medium', is the medium cooled (in a liquid or gas medium, or just cooled by thermal transmission)". Claim 12 does not specify how the medium is cooled. Figure 2 shows one embodiment wherein liquid nitrogen is provided, but other embodiments are within the scope of this claim.

Claims 13-20 are method claims, and therefore specify steps to be performed rather than apparatus ("means") for performing them.

Anticipation Rejections Under 35 U.S.C. § 102(a):

The Examiner states that Mollenauer 3,970,960 shows "a single stage laser amplifying apparatus, comprising a pump laser, an oscillator assembly, and an amplifier having a medium being cooled cryogenically . . . ." The applicant requests that the Examiner point out where these elements are found.

The Mollenauer reference is directed to a cryogenically cooled "color center" material amplifier. Color center materials break down easily, and this degradation of the laser medium can be prevented or slowed considerably by cryogenic cooling. From the Description of the Prior Art from the present patent application (Page 2, Line 17 to Page 3 Line 11):

> Other prior art inventions focus on amplifying ultrashort pulses in color-center laser media or very similar f-centers media. In these lasers, the active medium is a crystal (NaCl, KCl, and others) that can be temporarily "damaged" using radiation. The damage sites in the crystal (f-centers or color centers) can act as the "dopant" or active atom in the host crystal, and lasers and laser amplifiers can be made using these media. However, these color centers will anneal-out of the crystal over time, and this usually necessitates cooling of the crystal to cryogenic temperatures to avoid fading-out of the lasing action. Ultrafast and other amplifier systems using these media have been built. <u>However, the distinguishing characteristics of these systems</u>

from the present invention is that 1) the reason for cooling is primarily to preserve the laser medium, not to enhance its optical and thermal characteristics; 2) the power level of these lasers has generally been lower, not higher, than that of the prevailing ultrafast laser-amplifier technology; i.e. less than 100 milliwatts (as opposed to several watts); and 3) the total gain demonstrated in any of these systems has been limited to well under 10^6 (2.2×10^5). In none of these works are the thermal or thermal-optic characteristics of the material even mentioned, since in general this is not a consideration for lasers emitting average powers of <<1 watt. (Emphasis added)

The Mollenauer reference does not teach a system capable of "amplifying . . . from on the order of 10^{-9} Joules to on the order of 10^{-3} Joules . . ." as claimed in Claims 1 and 13. An element of each independent claim is not present in the cited reference. Hence, Applicant respectfully traverses the Anticipation rejections.

Obviousness Rejections Under 35 U.S.C. § 103(a):

As discussed in the previous section, the Mollenauer reference does not teach a system capable of "amplifying . . . from on the order of 10^{-9} Joules to on the order of 10^{-3} Joules . . ." as claimed in Claims 1 and 13. Nor could this type of system be modified to achieve this kind of performance, as the materials used would neither withstand these power levels or operate properly at these power levels. There is no suggestion in the references cited by the Examiner, or other prior art references known to the inventors,

to use cryo-cooling to achieve the kinds of performance the present invention achieves in a single stage of amplification.

Appendix A is an affidavit by Dr. Henry Kapteyn, an inventor on the present application and a person skilled in the art of ultrashort pulse amplification. He states that it was "not obvious" to him or his co-inventors "that adding a cryogenic cooler to to a laser amplifier would result in an improvement in the efficiency of pump light to laser light conversion" and that "it was a surprising result that both high overall gain and high optical-to-optical conversion could be obtained in a single stage laser . . . " using cryo-cooling.

Hence, Applicant respectfully traverses the Obviousness rejections.

The independent claims are patentable for the reasons described above. The dependent claims are patentable as depending on allowable claims, and also include additional patentable elements.

As all of the claims now in the application appear to be in condition for allowance, applicant respectfully requests that the application be allowed and passed to issue as soon as possible.

Respectfully submitted,
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Appendix A

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	10/062,584
Applicant	:	Backus et al
Filed	:	February 2, 2002
Title	:	Ultrashort Pulse Amplification in Cryogenically Cooled Amplifiers
Group Art Unit	:	2828
Examiner	:	T. Nguyen
Docket No.	:	C01.110

Declaration Under 37 C.F.R. 1.132

County of Boulder)
)ss.
State of Colorado)

Affiant, Henry C. Kapteyn, Ph.D., states as follows:

Affidavit of Henry C. Kapteyn, Ph.D.

I, Henry C. Kapteyn, being duly deposed and sworn, hereby state:

1) That I have obtained a B.S. degree from Harvey Mudd College, an M.A. Degree from Princeton University, and a Ph.D. from the University of California at Berkeley, all in physics. My Ph.D. thesis work was in the area of laser physics and in-part dealt with high-power, ultrashort-pulse ti:sapphire lasers.

2) I am well qualified as an expert in this field. I have been working in the area of ti:sapphire lasers and laser amplifier systems since the late 1980's. The first paper I co-authored in this topic[1] was among the first papers that demonstrated the generation of high-power, femtosecond light pulses using solid-state laser media. Since then, I have published as a research group principal investigator extensively on various aspects of ti:sapphire laser and laser-amplifier systems technology, with over two dozen papers specifically on ti:sapphire laser technology that have been collectively cited more than 1000 times.[2-33] A recent 25 year retrospective of the journal Optics Letters, the premier rapid-publication journal covering this field,[34] found that I am one of the 25 most cited authors in this journal, primarily on the basis of my work in ultrashort-pulse

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ti:sapphire lasers and laser-amplifier systems.

3) That I am an inventor in the above-identified patent application.

4) That prior to making the present invention, it was not obvious to me or to my co-inventors that adding a cryogenic cooler to a laser amplifier would result in an improvement in the efficiency of pump light to laser light conversion. In my prior work and that of my co-inventors, we employed a cryogenically cooled crystal as the second, low-gain amplifier in a "two stage" amplifier design. We did this because we knew that the high-gain, first stage amplifier worked well without cryogenic cooling, and we thought that the overall performance and efficiency of the laser system would be optimized by splitting the pump laser power, using a bit of it for a first stage amplifier, and then "seeding" the second stage amplifier with a relatively high energy obtained from the first amplifier.

5) That when my co-inventors and I tried a single-stage cryogenically-cooled amplifier system, it was a surprising result that both high overall gain and high optical-to optical conversion efficiency could be obtained in a single-stage laser. The fact that the advantages of this new configuration are not obvious is further evidenced by the long time-interval between the first work where we employed cryogenic cooling of a laser,[30] and the first work where we employed the single-stage, high-gain, high-efficiency, and high output power configuration that is the subject of this patent.[33] Since we have developed this new cryogenically-cooled configuration, we have been reconfiguring the several laser systems that we use in our research labs to the new single-stage cryocooled design.

6) That in my extensive knowledge of the literature in this area, including the prior art cited by the Examiner, no one before now has appreciated that both high overall gain and high optical-to-optical conversion efficiency to high-power pulses could be obtained in a single stage laser. Specifically, efficient single-stage cryo-cooled amplification from about 10^{-9} Joules to about 10^{-3} Joules, as claimed in claim 1 of the present patent amplification, has heretofore not been considered to be possible.

All statements made in the foregoing Affidavit which are from the Affiant's own knowledge are true and all statements made on information and belief are believed to be true.

HK.

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Further Affiant sayeth not.

Subscribed and sworn to before me this 5th Day of January, 2004

Cheryl Glenn
Notary Public

My Commission Expires 6/20/2005

Respectfully Submitted,

By

Henry C. Kapteyn, Ph.D.

Dated January 5, 2004

NISTCU

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